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Ionosphere Research at a LEO orbit with a CubeSats' HF Radio Spectrometer

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Small satellites provide new possibilities to study Earth's ionosphere and geospace. Especially, a type of nanosatellite (< 10 kg), CubeSat, provides a cost-effective possibility to provide in-situ measurements of the atmosphere and the ionosphere at low Earth orbit (< 1000 km), LEO orbits.

As an example, combined Suomi 100 satellite observations with ground-based instruments have given a new view on auroras [1] and ionosphere [2]. The Suomi 100 CubeSat was launched on Dec. 3, 2018 (https://www.suomi100satelliitti.fi/index_eng.html). This 1 Unit (10 cm x 10 cm x 10 cm) polar orbit nanosatellite performs geospace, the ionosphere and the Arctic region research with a white light camera and a radio wave spectrometer instrument that operates in the ~5 - 10 MHz high-frequency (HF) range. The satellite is in a solar synchronous orbit at an altitude approximately 590 km.

The presentation shows the results obtained and the lessons learned from the satellite's HEARER (High frEquency rAdio spectRomEteR) radio spectrometer instrument. Especially, we present results from global measurements collected continuously for one second on multiple full orbits. We also introduce numerical simulations developed to interpret the observations. Furthermore, we discuss the planned new joint research campaigns involving the Suomi 100 satellite and the HF heater transmitter facilities.

Figure 1. A composite figure displaying the Suomi 100 satellite photographed prior to launch, along with a dayside photograph of the Earth taken by the satellite from its orbit.

1. E. Kallio, Harri, A.-M., Knuuttila, O., Jarvinen, R., Kauristie, K., Kestilä, A., et al. (2023). Auroral imaging with combined Suomi 100 nanosatellite and ground-based observations: A case study. Journal of Geophysical Research: Space Physics, 128, e2023JA031414. https://doi.org/10.1029/2023JA031414

2. E. Kallio, Kero, A., Harri, A.-M., Kestilä, A., Aikio, A., Fontell, M., et al. (2022). Radar—CubeSat transionospheric HF propagation observations: Suomi 100 satellite and EISCAT HF facility. Radio Science, 57, e2022RS007516. https://doi.org/10.1029/2022RS007516